Carol Granneman and Arjan Goris

Kazakhstan, Offshore Exploration in the Caspian Sea

Carol Granneman

Carol Granneman received an MSc in Civil Engineering from Technical University Delft (The Netherlands) in 1984 and an MBA from Henley Management College (UK) in 1998. In 1990 he joined Boskalis, starting in the IT department and later working in the Marketing Department. Work in Kazakhstan comprised managing QA/HSE, Production/Planning for the project and Superintendent. He is presently working as a Project Manager for Boskalis in Norway.

Arjan Goris

Arjan Goris graduated with a MSc in Mining Engineering from Technical University Delft (The Netherlands). For the past 14 years he has worked for several mining companies in underground and open cast mines in South Africa and South America, the last 5 years of that as Head Mining Operations of a bauxite mine in Surinam. He joined Boskalis Westminister in 1998 and was sent to Kazakhstan. Since mid-1999 he has been Boskalis' Project Manager in Kazakstan, responsible for all operations and contacts with the client OKIOC.

Abstract

In 1998, nine international oil companies formed an operating company in Kazakhstan, OKIOC (Offshore Kazakhstan International Operating Company), to carry out a six-year oil and gas exploration programme in the Kazakh sector of the Northeast Caspian Sea. At the drilling areas, OKIOC contracted with Boskalis International b.v. to build underwater berms to withstand the forces of waves and moving ice. Although the size of these berms are not especially large, the real challenges being faced during this project are the sensitive environment, the complex local regulations, the poor quality of the rock, the harsh climate and the overall logistics and safety, as well as the deep cultural differences.

Introduction

In 1998, nine international oil companies formed an operating company in Kazakhstan, OKIOC (Offshore Kazakhstan International Operating Company), to carry out a six-year oil and gas exploration programme in the Kazakh sector of the Northeast Caspian Sea. The offshore exploration programme covers an area of 6,000 km^2 (see Figure 1).

The seismic programme started approximately six years ago and in August 1999 exploration drilling began for the first time in the Kazakhstan sector of the Caspian Sea. The result of this exploration hole became available in the summer of 2000, and forms the basis for an anticipated increase in activities in the north-eastern sector of the Caspian Sea.

Five exploration holes have been nominated:
- Kashagan East,
- Kashagan West,
- Kalamkas,
- Aktote and
- Kairan.

A drilling barge has been modified to allow drilling in shallow waters and for drilling under the extreme winter conditions existing in this part of the Caspian Sea. The barge was widened, equipped with ice deflector shields and with all necessary equipment to continue its drilling operation during the winter. It is placed on top of a berm, with the purpose of this berm being to provide a footing and stability at a pre-determined depth (depending on prevailing water levels in the Caspian Sea).

Boskalis International b.v. has been involved in the construction of these berms during the construction years 1998-2001.

Kashagan East was the first exploration location, at which the drilling rig began the search for oil and gas. The drilling depth of this well was expected to be 4,500 m, but was later extended to beyond 6,000 metres.

Figure 1. Location map of the area and of the two exploration holes presently drilled.

The Local Circumstances

OKIOC has a Production Sharing Agreement with the government of Kazakhstan. One of the terms of this agreement deals with the local content of personnel and equipment to be used under the agreement. Implicitly this means that a large part of the operation has to be executed with local equipment and personnel.

After more than two years of experience in Kazakhstan, a better understanding and relationship could have developed between the Contractors and the local authorities. Unfortunately, this situation has not materialised, and many problems that the Contractors face are related to local authorities pursuing their own (hidden) agendas and requiring an ever-bigger input in the operations. This situation is true for all the companies involved in the project, with the bigger and more renowned companies facing the same or even bigger problems.

The pressure is for a large part related to the very high unemployment in (West) Kazakhstan. Towns, districts and regions are fending for themselves and competing with each other for econonic development. Each has its own targets and problems, and does not favour the employment of personnel from other regions of Kazakhstan (not even from a nearby city).

To illustrate the local differences, not so long ago the local mayor of Fort Shevchenko (Akim) ordered Boskalis to dismiss an employee living in Aktau, on the (illegal) grounds that only people from his district were allowed to work within his district. Having adhered to that request/demand and having dismissed the said employee, a court order from the city of Aktau arrived that this was an illegal act, and a penalty had to be paid by Boskalis in order to alleviate any further legal actions. The Akim in Fort Shevchenko did not take any responsibility for this action, and pretended to know nothing about the instruction.

With a constant request for your passport, travelling between the neighbouring regions of Mangistau and Atyrau give the illusion that you are travelling to another country. In addition, the old Soviet system of foreigner registration in any new district still applies, with each district (town) using its own rules and habits, which makes travelling within Kazakhstan a very cumbersome affair.

The application for any permit or permission to work involves often more than one Ministerial Department. Ministries of Ecological Affairs, Transport, Fishery and Foreign Affairs are scrambling to have the final say in any application, which makes the process a long and tedious affair. To omit one Department in the application process could result in the total rejection of the application and the formulation of an "Act". The Act will state all violations of the Kazakhstan Laws and is the basis for further penalties and fines. The first time such an Act is made, it becomes clear that this system is a remnant of the Soviet system in which responsibilities, accountabilities and further actions are pushed as far as possible away from the investigating party.

The Berms

The term berm applies to an artificially constructed underwater island, which consists of rock material in different gradations, and which is designed to withstand wave actions and ice forces. Owing to the size

of the barge and the requirement to drill in an exact vertical angle, the top of the berm needed finishing within very narrow tolerances.

The first two berms (Kashagan East and Kashagan West) were part of the contract between OKIOC and Boskalis International b.v. The berm at Kashagan East was finished in the autumn of 1998 and the second berm in Kashagan West was completed in the summer of 1999, well ahead of the arrival of the drilling rig. Slightly different designs were used for these berms, but both designs included the use of "ice-breaker piles" to protect the berm and the drill rig against the substantial forces of moving ice during the winter and spring.

Although the volume of these berms (11,000 t and 44,000 t) is small in comparison to "standard" rock projects, other elements make this project unusually complex. To mention a few: the sensitive environment, the complex local regulations, the poor quality of the rock, the harsh climate and the overall logistics. All together they formed an exceptional challenge to complete the works within the tight boundaries of time, design and safety requirements.

The Environment

The Northeast Caspian Sea is a State Nature Preserve Zone because of the unique combination of shallow waters (the water depth in the entire North Caspian Sea does not exceed 10 m), marine organisms, a nesting and feeding place for birds, and the presence of indigenous vegetation. The coastal wetlands provide the habitat and breeding grounds for many species.

Figure 2. Water pollution in the North Caspian Sea has taken its toll on the sturgeon and the caviar derived from it. New legislation has been created to restore and preserve the sturgeon population.

The region forms an internationally important area for birds, since it is on the migratory route of many species.

Another important factor is the presence of the sturgeon in the area (Figure 2). The economic importance of the sturgeon and its caviar is tremendous, and pollution has taken its toll on the sturgeon population in the (North) Caspian Sea. The introduction of a tough environmental legislation is aimed at preserving and restoring the sturgeon's habitat and to avoid a further decline in its numbers.

OKIOC adopts a very strict discharge policy that does not permit the discharge of any drilling wastes or solid wastes from its drilling rig (only allowing highly treated sewage waters) and no discharges from any of the marine vessels in the project. It requires all vessels and barges to be equipped with separate wastewater tanks and the means to discharge it in the port of Bautino. In addition, waste separation is enforced by Boskalis, which requires constant training of, and promotion to (in particular) the Russian and Kazakh crewmembers.

From a hydrodynamic point of view, the area is particularly interesting. There is no tidal movement, but flooding of the coastal wetlands occurs frequently when wind force and direction causes the water level to rise in particular areas. Rise and fall of the water level lie within a range of +0.50 m and –0.50 m. Unfavourable winds in combination with a reduced water depth could hamper the placement of the drilling barge on top of a berm, and, during the second rig move, this condition played a prominent role in the decision-making process.

Another important issue is the long-term change in the water level of the Caspian Sea. After several years of water level declines, the water level suddenly started to rise between 1994 and 1997. A rise of approximately 2.4 m was measured. Since then the water level has been stable but fluctuations of 20 cm each year are not uncommon. Major changes in the design of the berm were caused by the evaluation of water level predictions, both short-term and long-term related.

The Climate

The Northeast Caspian Sea is one of the harshest environments in which to work. With an average temperature in the summer of close to 40°C, with periods of 50°C, and an average temperature in the winter of less than –10°C, with periods of less than –30°C, the organisation had to be prepared for the most difficult circumstances (Figure 3).

Take the temperature change on 29 November 1998 as an example: from approx. zero to minus 39 (including wind chill) in 16 hours. The mooring ropes were not designed for these temperatures and conditions, and

many snapped owing to the accumulation of ice during this cold spell. With waves washing over the aft deck of the Multicat, an ice layer of 10 cm thick was formed within hours.

A similar situation occurred during the last onset of winter, when the Northeast Caspian Sea (an area not less than 30 by 50 km) was frozen solid (4-5 cm thickness) within 24 hours. Imagine a normal flowing river being frozen over within a 24-hour period, with many fishermen on top of the ice cap fishing through a man-made hole in the ice only half a day later.

The abrupt weather changes are caused by strong winds, shifting to easterly directions, which bring the Siberian cold over the plains of Kazakhstan without any obstruction to decrease wind speeds. As a rule, the Northeast Caspian Sea is covered with ice during the winter, stretching as far as Bautino in severe winters.

Summer temperatures are high, and with the absence of precipitation change the landscape into a steppe with very limited vegetation (approx. 20 cm high, sparsely distributed). Moderate winds create enormous dust clouds, which enter into any nook and crevice onshore. Offshore, this same wind provides some relief during these high temperatures and is welcomed by many.

Figure 3. The temperatures in the North Caspian Sea area are some of the harshest and most extreme in the world.

Figure 4. The port of Bautino, a seaside village at a distance of approximately 180 nautical miles from the first berms, was the closest location where (construction) rock was available and could be loaded onto barges.

The Design

The original design of the berm at Kashagan East was based on assumptions of certain water levels in the North Caspian Sea and estimates of draught and size of the drilling rig. An extensive campaign in 1998 to measure the water levels at the drilling locations gave more information about the water level in the Caspian Sea and the short-term variations. At the same time, the drilling rig was assembled in Houston, Texas, USA, and it was not clear what the draught of the barge would be, especially since further modifications were planned in Astrakhan, Russia.

No material in the direct vicinity of the berms was suitable for the construction, and the dredging option could therefore be excluded during this design phase. With extensive marshlands on the Northeast coast, the closest location where (construction) rock was available and could be loaded onto barges was in Bautino, a seaside village at a distance of approximately 180 nautical miles from the first berms. The Bautino village is part of a cluster of three villages together with Atash and Fort Shevchenko, and is located at a distance of about 150 km from the nearest city of Aktau (Figure 4).

This location was finally chosen as the base from where Boskalis would manage its operations. OKIOC also located its supply base and base for recycling drilling mud in Bautino, and constructed the civil works from the same (rock) material.

After several changes in the design, it was finally decided that the top of the first berm would be at a level of –3.0 m under mean sea level, whereas the second berm was finally completed at a level of – 3.2 m under mean sea level (Figure 5).

There were several rock gradations engineered for the different berms and an artificial island: three outside layers of armour rock each with a different size were

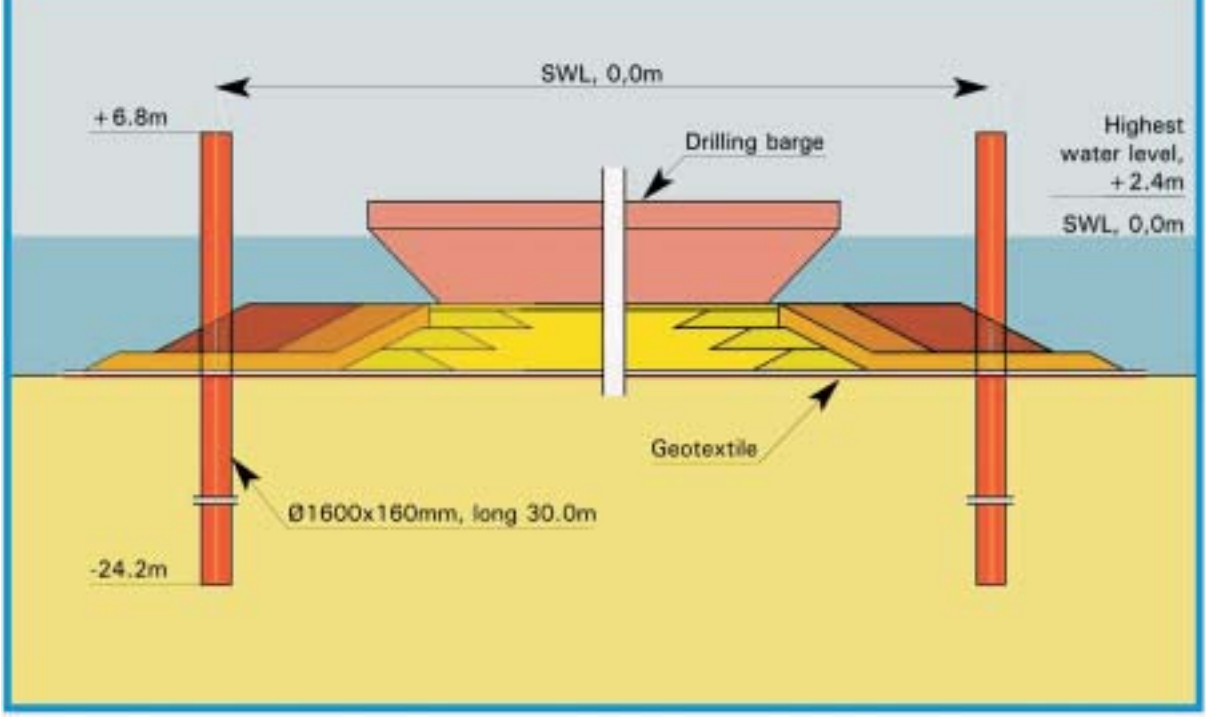

Figure 5. Schematic drawing of the berms with the geotextile mats.

designed to protect the outside perimeter of the berms, and varied in weight between 20 kg and 9 tons. This requirement considerably complicated the logistics in the quarry and the stockpile.

The core of the berm consists of 0-20 kg material, whereas the island was to be constructed with core material between 0 and 35 kg. In addition, material used for the ballasting of the geotextile mats was graded rock with a size between 50 and 150 mm, whereas the top layer of the berm consists of 10-50 mm graded stones. The latter material had to be placed within very small tolerances, +0 cm above its level, and maximum variances of –10 cm over a 10-metre length below the design level, over the complete area of approximately 50 m x 70 m.

Figure 6. Unrolling the geotextile mats.

The Geotextile

The design required geotextile to be placed underneath the berm. The purpose of the geotextile was partly to avoid local slip failures over a soft in-situ clay layer and partly to separate the original seabed from the new structure above.

The geotextile mats with a width of 10 m were rolled on a pipe and lowered onto the seabed. By fixing the starting point with a heavy H-profile beam, it was possible to unroll the geotextile over a length of approximately 50 m. Accurate positioning and careful ballasting of the geotextile made it possible to complete the operation without the use of divers (Figure 6).

Two rows of 12 steel (ice-breaker) piles were placed on the north and south sides of the berms.
The dimensions of a pile were:
– length: 30 m,
– diameter: 1.6 m and
– wall thickness: 55 mm.

A subcontractor of Boskalis (McDermott) placed the piles during a two-week piling campaign in September/October 1998.

The Rock and Quarry

The characteristics of the material used in the design to withstand the wave and ice forces on the berms and the island were entirely different from the actual material found in the quarry. The rock was an alluvial deposit of limestone, and consisted of individual shells cemented together in a very porous structure. The reason for the difference between actual and design qualities was the presence of a weathered, but more compact, rock layer at the surface during the time of the quarry investigation.

During actual quarry operations, it became apparent that the underlying rock layers were considerably more porous. Consequently, the average (placed) density of the rock was as low as 1,276 kg/m^3, which posed an extra challenge to the engineer and the Contractor to comply with the requirements of the contract. As a result, the second berm had to be redesigned considerably to cope with the actual rock characteristics.

Prior to any activities, a quarry existed in the direct vicinity of Bautino (Fort Shevchenko), but it could not produce the right mix of materials for the berms. First rock deliveries were made from this quarry, but simultaneously a new quarry was developed (Atash) which was taken into production during September 1998. Necessary preparations included the installation of a (jaw) crusher and a screening plant to produce the graded rock as was stipulated in the contract and later amendments (Figure 7).

Figure 7. The rock from the local quarry was an alluvial deposit of limestone and more porous than originally thought, so a new quarry was developed.

All work in the quarry was subcontracted to Bechtel-Enka, a joint venture between the American company Bechtel and the Turkish company Enka. A local subcontractor did the actual drilling and blasting of the rock, whereas the transport of the rock to the Bautino stockpile over a distance of approx. 11 km, was done with local trucks (Figure 8). At the Bautino stockpile all individual trucks had to pass a weighbridge in order to establish the net tonnes delivered to the stockpile (of each gradation).

At the end of the construction year 1998, a total quantity of 203,000 tonnes of rock had been produced from the quarries and placed on the stockpile close to the loading point in Bautino (Figure 9). The stockpile area was created on the shore side and included a jetty and loading facility to enable the trucks to drive onto the flat-top barges. This jetty was in use by the Kazakh Navy prior to 1998, but was extended further by the Contractor to allow for proper mooring of the barges and the installation of a Bailey bridge type ramp.
The design was kept simple, especially since the construction period was estimated at six months. Now, more than two years later, the same facilities are being used and the contract with OKIOC has been extended another year until October 2001, still based on the same (but slightly modified) facilities.

Figure 8. The transfer of rock to the Bautino stockpile was done with local trucks.

The Operations

Kashagan East (K.E.-1) is located about 40 km from the northern shore of the Caspian Sea, close to the Kazakh City of Atyrau. Kashagan West (K.W.) is located approximately 40 km to the west of Kashagan East.

Local equipment

Although Kashagan East was to be constructed with a relatively small quantity of rock, the time it took to build this berm was much longer than expected. The design changes as discussed earlier, the new and "hostile" environment, and the starting-up problems all contributed to the slow progress, but also a very important factor was the type of equipment used during the first year. The Contractor decided to make use of "local" equipment, and rented for that purpose barges, tugboats and a jack-up platform equipped with a hydraulic excavator from Russian suppliers (Figure 10).
The combination of old and ill-maintained equipment, and a Russian crew without offshore experience and with an immense language barrier, made it impossible to achieve the required accuracy and productivity.

Figure 9. A total quanitity of more than 200,000 tonnes of rock was produced from the quarries and stockpiled in Bautino.

Figure 10. Meeting standards and goals during the first year was made more difficult because of the old and ill-maintained "local" equipment – barges, tugboats and a jack-up platform equipped with a hydraulic excavator – rented from Russian suppliers.

For the second construction year, better equipment was brought in from the Netherlands (a state-of-the-art hydraulic excavator, wheel-loader and new tugboat) and the Russian equipment was limited to three barges. It should be noted that over time, the Russian crewmembers improved their knowledge and understanding of acceptable work methods, in addition to the improvements they have made in their knowledge of English, making communication that much easier. As a result, productivity has improved substantially and operations can be considered successful during this third production season.

Personnel

The next challenge is the training of Kazakh employees to replace the ex-pat personnel. The Labour Laws and political pressure are mounting to implement strict targets to comply with these laws, and the issue of labour licenses for ex-patriate personnel is becoming more and more difficult.

Although many local people profess to have proficiency in offshore work and the necessary experience, this is not evident. The local people are generally working on the fishing fleets of the Caspian Sea, on vessels which lack modern equipment and they themselves lack knowledge in construction skills. This is not an argument that is accepted in discussions with the authorities, and the only solution is to employ people and train them on the job. This process will have to continue for the coming year(s), and although in the short term it is quite difficult and expensive, it should be beneficial in the long run, since hiring indigenious people is more economical than importing labour from abroad (Philippines).

The remoteness of the berms necessitates the inclusion of an accommodation vessel into the Contractor's fleet. All offshore employees are housed on board this vessel, and crew changes are done via the OKIOC helicopter service to Atyrau. The accommodation vessel, the Baskunchak, which means "dog's head" in the local language, is sparsely equipped and lacks any sporting facilities or other leisure opportunities as is customary on more modern vessels (Figure 11).

There is a no-alcohol policy and with limited entertainment possibilities, the atmosphere is work, work and more work. The present offshore work schedule of 28 days on and 28 days off is a near necessity to attract personnel to this location.

Supply station

The Contractor's supply station is situated in Bautino, where the barge loading operations are situated, as well as many of the local authorities (police, customs, immigration, labour office and so on). The office is mainly run by a technical inspector (also for backup for the offshore operations), an office manager and one

translator/junior secretary. Because the local authorities require substantial attention, the office seems to exist only to serve as a copy centre, PR centre and postbox for complaints and civil punishments.

In addition the Contractor has an Administrative centre in Atyrau which deals with all regional and central authorities, and which keeps track of all internal administration and the liaison with Head Office in Papendrecht. This geographically spread-out set-up is cumbersome and needs some re-organisation in the future.

Equipment

Initially three flat-top barges with capacities of approximately 2,500 tonnes were used for the transportation of the rock to the berms, but this number has been reduced to two for the last two years. All barges are hired from Astrakhani shipping companies. Although not self-propelled and lacking any modern facilities, these barges are manned by a crew of five persons.

The HSE and QA awareness on board of the Russian vessels was at a dramatically low level and had to be upgraded before they could be used in the project. Although substantially improved, this vigil for HSE and QA related issues remains a necessity for future operations.

A third barge is equipped with winches and every conceivable satellite positioning gadgetry, and is used as a mooring and working platform for the hydraulic excavator and for (sporadic) diving operations. Two Russian persons permanently operate this vessel.

The hydraulic excavator is a Caterpillar 375L, has its own on-board (satellite) positioning equipment, and is equipped with a Crane Monitoring System (CMS) to assist the operator in the underwater construction activities. This CMS has proven instrumental to a smooth operation (Figure 12).

Lately a tugboat has again been rented from the Russian Federation (Astrakhan) and, although only thirteen years old, she looks and behaves as a vessel from the early fifties. Installed horsepower: 800 PK, lub consumption 4 ltr per running hour and a crew of twelve.

The crewmembers are unaware of any HSE policies, and require nearly daily guidance in good housekeeping and marine practices. Not that they are not interested, but they have never been exposed to these kinds of (strict) rules and practices and are overwhelmed by the level of technical designs for the excavator and the (Dutch) tugboat. The idea of a bow thruster is new to them, but they clearly appreciate the added value of such a device.

Figure 11. Because of the remoteness of the berms, the accommodation vessel, the Baskunchak, is used to house offshore employees.

Figure 12. A hydraulic excavator is equipped with its own on-board satellite positioning equipment and Crane Monitoring System (CMS) to assist the operator in the underwater construction activities.

HSE and QA Requirements

OKIOC, being a part of the oil industry, required from Boskalis International a state-of-the-art HSE and QA implementation. A project HSE case was developed using state-of-the-art techniques. A full size bow-tie risk analysis of the project using the Thesis computer model was made for the project. These requirements applied for Boskalis, as the Contractor, but also for all subcontractors working for Boskalis.

Figure 13. A tugboat rented from the Russian Federation, though not old, behaves as a vessel from the 1950s.

Although Boskalis has a corporate HSE and QA management system, which is used on all projects being executed under its responsibility, it proved another challenge to bring local contractors and personnel up to standard and to the targets set by OKIOC.

All locally hired equipment and in particular trucks (all Russian-made) have to be checked and approved to operate under the requirements set by the Contractor. Also their drivers are instructed in daily sessions to bring them to a level which is required to operate safely.

Presently, the Contractor has embarked on a programme to have all sub-contractors apply their own HSE and QA programmes for the equipment employed at the Boskalis contract. Upon the introduction of this programme to the sub-contractors, reactions varied ranging from silent resistance to outright protest – a threat to increase prices by 30% due to this request to implementation. It was only after further discussions that both companies accepted the first phase, an inventory of already existing HSE and QA procedures within their organisations, and a commitment to gradually improve those procedures for the construction year 2000-2001.

Further implementation of procedures will take time and requires subcontractors' understanding that these measures could potentially save money and could be an assurance for additional work in the long run.

The Logistics

The Caspian Sea can only be reached over water via the Don-Volga Canal or the Canal System through Russia starting in St. Petersburg. Add to this that all canals are closed from mid-November until the end of March and it becomes clear that planning of transport has to be done very carefully.

High quality material is not available in the western part of Kazakhstan and therefore all materials and equipment have to be brought to site by truck (taking at least fourteen days from Holland), by plane or by boat (taking at least four weeks from Holland). Custom clearance makes these operations extra complicated and can easily delay these transports even more.

To illustrate this point, this summer a truckload was delivered to Bautino and, upon inspection by the customs, was confiscated because the cargo information on the waybill did not correspond with the actual contents of the truck on site. Problem: a few oil filters had been added at the very last moment and were not added to the waybill documentation. It took six weeks to get this delivery released from Customs, and required a great deal of time and paperwork before this could be arranged. An express truck with very urgent materials for Kashagan was held up in September for four weeks in Russia because the paperwork (of another company) was incorrect.

Yet, despite language and culture problems and a lack of understanding of all applicable rules and regulations in Kazakhstan on the part of the Contractors, most problems with the local authorities are eventually solved.

As for the local people, generally speaking they are amicable and willing to assist, and in the end, interested in the improvements that this technology can bring to the Caspian Sea.

Conclusions

With the first two berms successfully completed, the Boskalis contract with OKIOC has been extended to the year 2000-2001˙ still, several important challenges need to be met:

- the training of Kazakh employees to replace the expat personnel. The Kazakh Labour Laws and political pressure are mounting to implement strict targets to comply with these laws, and the issue of labour licenses for ex-patriate personnel is becoming more and more difficult;
- an inventory of already existing HSE and QA procedures has been made amongst the organisations, and a commitment to gradually improve those procedures for the construction year 2000-2001 has been accepted. Further implementation of procedures will take time and requires subcontractors' understanding that these measures could potentially save money and could be an assurance for additional work in the long run.
- the Contractor's Administrative centre in Atyrau which deals with all regional and central authorities, and which keeps track of all internal administration and the liaison with Head Office in Papendrecht is geographically spread-out which is cumbersome and needs some re-organisation in the future.

Environmental Aspects of Dredging
Guide 7: Frameworks, Philosophies and the Future

In this seventh and final guide in the series "Environmental Aspects of Dredging", entitled *Guide 7: Frameworks, Philosophies and the Future*, Mr RN Bray of Dredging Research Ltd. draws all the previous guides together to provide a synthesis of the series and takes a look to the future.

The author discusses a selection of points which have arisen during the several years which have spanned the production of the series. These points may have been either overlooked, unresolved or generally in need of airing. Then, looking to the future, the author seeks to identify subjects for detailed research and/or greater discussion.

The first chapters re-examine the objectives of the series and re-emphasize the Environmental Policy of the World Organisations of Dredging Association (WODA). Each of the six guides is then succinctly summarised, with commentary on some of the issues raised by them.

The middle chapters look at the "philosophies" which inform dredging activities: the scope of environmental evaluation and cumulative effects analysis; data collection; impacts and evaluation of beneficial uses; the differences between preservation, conservation and sustainability; the role of mitigation and compensation; and the effects of turbidity and suspended sediments on the aquatic environment.

The final chapter looks to the "future": to the continuing development of environmental awareness; to the effects of climate and to the concept of partnering and active public participation. The author considers the development of environmental economics so as to create a balance between economy and ecology, and a list of possible future research topics has been suggested.

Finally, an indispensable part of Guide 7 are the two indices of the whole series. One index has been categorised by subjects and the other by placenames. This creates a fitting close to this elaborate series of environmental books and provides a useful aid to readers in accessing information from the entire seven-book series.

The Complete Series

Though Guide 7 is written as a stand-alone document, it is best used in conjunction with the other Guides in the series. The complete series, which comprises seven books, is a joint effort of the International Association of Dredging Companies (IADC) and the Central Dredging Association (CEDA). An Editorial Board comprising members from both associations has been actively involved in the development of the concept. Other books in the series already available are:

Guide 1: Players, Processes and Perspectives, written by Jan Bouwman and Hans Noppen of AVECO bv, is an analysis of the players involved in reaching a decision to dredge and creates a system for assisting these decision-makers.

Guide 2: Conventions, Codes and Conditions; Marine Disposal and Land Disposal, written by Elena Paipai, T. Neville Burt and Carolyn Fletcher of HR Wallingford, presents the international conventions governing disposal of dredged materials and examines how various national legislation complies with this.

continued on page 36